

STATE OF PROGRESS IN THE USSR TO DATE ON THE PROJECT;

"METHODS AND MEANS OF AUTOMATION AND REMOTE CONTROL OF IRRIGATION SYSTEMS"

Water Resources

State Dept. declassification & release instructions on file

The investigation into the methods and means of automation and remote control in the USSR has been conducted mainly within the framework of the program "To Develop Methods and Technical Means of Complex Automation of Water Diversion, Regulation, and Recording for the Main Structures of Irrigation Systems, thus Increasing the Productivity of Labor During Water Distribution and Application." The project has been divided into five independent parts:

1. Develop the technological basis for complex automation of irrigation systems according to irrigation zones and types of irrigation systems.
2. Develop and introduce methods and means of automating head-works supply of water to irrigation systems ^{with} ~~and~~ gravity-flow ~~and~~ ~~of our~~ pumped diversions.
3. Develop methods and means of complex automation of inter-farm open and closed irrigation networks and conduct tests on them in irrigation systems in various zones of the country.
4. Develop methods and means of automating on-the-farm open and closed irrigation networks in various zones.

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systems.

The following organizations have taken part in the work on these projects: The Ministries of Reclamation and Water Management, of Instrumentation Manufacturing, of the Means of Automation and Control Systems and the Academy of Sciences of the USSR and Union Republics.

The state of development of the above listed parts can be briefly characterized in the following manner:

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Part I.

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Develop Technological Basis for Complex
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Automation of Irrigation Systems According
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to Irrigation Zones and Types of Irrigation
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Systems

As the result of work on Part I, "Basic Proposals for Automation of Typical Technological Processes in Reclamation and Water Management" has been completed. In these proposals the typical technological processes have been identified; the problems, degree, and stages of automation have been developed; and the features and the extent of their automation and the form of control of automated water-reclamation systems have been determined. At the present time, a new revised edition of the proposals is being prepared.

Using the probability approach, a method has been developed for computing the amplification factor and the lag time of automatic direct-

Approved For Release 2002/03/28 : CIA-RDP79-00798A000600100034-4
and indirect-operating water-level controls. The program for computing these parameters on electrical computers has been compiled and refined.

As a result of the study of technological basis for canals in the valley-plain zone, recommendations had been made for the technological operation of automated water diversion of hydrocomplexes.

A specified volume of research was conducted on the problems of creating and introducing the principles ^{for} of structuring automated irrigation systems with cascade regulation of water discharges. At the present time, the ~~theoretical and practical bases~~ ^{theoretical and practical bases} of such systems have been developed. An analysis of the test data shows that the introduction of cascade regulation makes it possible to obtain the essential economic advantage in irrigated farming, because of the reduction of unevenness in the water-conveyance graph within a system.

The work on the investigation of the technological schemes of automated irrigation sediment traps has been completed resulting in three original designs of automatic devices to control flushing sluices by using hydraulic and electric energy.

In the irrigation canals of the mountain-foothill zone, a system has been developed for automatic water-level control with external cross-couplings. The system has been installed with hydraulically operated

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proposals for designing these systems have been developed and
experimental investigations of a test system are being conducted.
Work on classification of water reclamation systems and their com-
ponents, such as their control features and the parameters of
control and regulation, is in the final stages. As a result of
this work there will be a different type of catalog of technical
features and technological parameters of control, measurement and
regulation.

Part II

Develop and Introduce Methods and Means of Automating Head-works Supply of Water to Irrigation Systems ^{with} and Gravity-flow of our Pumped Diversions

Investigations on this part were conducted for the purpose of creat-
ing the methods and means of measuring water level and discharge at
headworks diversion structures, the methods and means of regulating
the productivity of pumping units, control systems for pumping
plants, and information-measurement systems for forecasting river
runoff in systems when ^{diversion} in unregulated water development, and control
^{points} centers for electric drives at headworks GTS 1/.

From measuring water level in reservoirs and dam piezometric wells,
an acoustic digital level meter was developed and calibrated for

measurements of 1/10 and 1/64 meter, a system of centralized control has been built based on this level meter, the test units of which are in operation on a number of projects. At the present time an acoustic level sensor and a system of centralized control of water levels have been given over to industry for mass production.

At a number of features a controlled electric drive is being operated in a "thyristor converter-dc motor" scheme recommended for use in field pumping plants with a unit capacity up to 165 kw. Also, a controlled electric drive is being operated in a scheme of ~~con-~~ ^{rectifiers} ~~verters~~ with asynchronous-valve cascades recommended for use in pumping plants with a unit capacity of 160 to 800 kw.

Investigations have been conducted on creating an automatic information-measurement systems for operational forecasting of runoff. The theoretical and experimental development is proceeding on the structure and operating conditions of such systems for collecting information on all parameters necessary for this purpose.

Investigations have been conducted on a microwave radio path in mountain-foothill and mountainous conditions, and recommendations have been made concerning the organization of radio remote control communication channels using typical microwave radio stations.

A hydrological model has been ~~soon~~ developed which is based on multiple regressive linear equations by means of introducing a linearity in the argument. In the

According to the technical requirements for an enclosed automatic electric drive, control points have been developed for gates with screw hoists. At the present time these are in series production. Compilation of a catalog of the means of the control, measurement and regulation recommended for use in automation projects for head-works structures is being completed.

Part III

Develop Methods and Means of Complex
Automation of Inter-farm Open and Closed
Irrigation Networks and Conduct Tests on
Them in Irrigation Systems in Various
Zones of the Country

Development and research has been conducted on the design of in-channel water-measuring structures for open networks, for free-flow pipelines, and for various designs of closed turnouts. Tests have substantiated the design of slope measuring instruments made from double membrane-divided boxes, off-side level-gaging stilling well with damping, and electromagnetic discharge meters for complex operating conditions in pumping plants. Working designs have been drawn up on the basis of the investigations conducted earlier for a double-component discharge meter in open regulated channels and devices for measuring flow velocity in open channels based on an induction method.

A mathematical model has been developed for a localized system of automatic water-level (discharge) control in channels, and preliminary recommendations have been made for selecting the parameters of the means for local automated hydraulic equipment.

Laboratory and field investigations have been conducted on hydraulically operated devices for water level and discharge regulation.

Investigations have been conducted on the use of stands for modeling the means of local electric automation equipment for regulating water level and discharge, on the basis of which engineering methods for designing these automatic controls have been developed.

The development and testing of control points for enclosed electric drives for slave mechanisms in hydraulic structures (gates with screw hoists) have been completed. As a result of satisfactory testing of the operating efficiency of the control points as a whole and their individual components of establishing the reliability of the drive activated by signals from remote sensors or devices, and of the effectiveness of protecting these control points under various operating conditions, these control points have been recommended for series production.

Experimental investigations were conducted on the devices which make it possible to use transmission lines as communication channels.

Based on a study of the static and dynamic characteristics of irrigation systems, recommendations have been made for methods of centralized dispatching control and regulation of water distribution.

The development and introduction of the means of for setting up dispatching points in irrigation systems have been completed. These include the following apparatus: Control boards, graphic control charts, dispatcher posts, digital printing elements, information receiving elements, control system elements, elements for signalling deviation of a parameter from normal, water level and discharge sensors with "shaft-code" converters (single-pass and multiple-pass).

The results of production testing is positive.

Part IV.

Develop Methods and Means of Automating on-the-
Farm Open and Closed Irrigation Networks in
Various Zones

Specifications have been developed for the means of regulating and recording water discharges in on-the-farm networks.

Production testing has been conducted on water measuring devices for drain pipes in the wells of vertical and horizontal drains. A number of automatic devices have been developed for sprinkling machines,

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such as head limiters, head regulators, and by-pass devices.

A complex of information elements have been completed for centralized data collection from automated systems of water application, including moisture sensors, salinity meters, and thermometers. Experimental-structural development of information-measurement systems for data collection on soil moisture has been completed. The system uses radio communication channels and has 40 control points at each of which 5 moisture sensors are installed.

Part V.

Develop and Test Means of Controlling Vertical
Drainage Systems

Investigations on this part have been conducted for the purpose for creating a technical basis for automatic control of vertical drain systems, development of systems for smoothing start-up and regulating the capacity of pumping units, production testing of developed control points for the units, and development and selection of remote control systems for regulating vertical drain wells.

At the present time vertical drain systems are being classified as to control features, basic specifications for control systems have been formulated, a physical-mathematical model of a vertical drain system necessary for developing algorithms for control of these features is being developed.

Control points made from solid-state elements have been developed which made it possible to assure a smooth startup of vertical drain units. The production testing is now being conducted.

A specialized induction-type discharge meter has been developed for pumped vertical drain wells. Field testing of this meter is being conducted on a test-production project.

/s/ Bilik